Data: Long-Term Supportability

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Agenda

- **Why Should A Program Manager Worry About Data and Tools to Store It Anyway?**
  - **What is Data?**
  - **What is Information?**
  - **From Data to Information…**
- **As You Plan, Consider**
  - **Example of Data and Information Needed for EIA 632 Requirements Management**
  - **Life Cycle Example for Process Enabler Tools and Interfaces**
- **Conclusions and Recommendations**

What is Data? What is Information?

Data

- The raw materials from which information is developed

EXAMPLE:

- A single “SHALL” statement
- A test result
- A specification change page

Information

- Data that has been transformed into a meaningful form for the user (customer, recipient)
-

EXAMPLE:

- A specification with many “SHALL” statements
- A test report
- An impact analysis of the results of a change

Data to One is… Information for Another

Program Managers Need Quality Data and Enabling Tools to…

- Develop appropriate information at the right time to help manage (minimize, mitigate) risk
- Build cooperation (trust) to get the job done more efficiently and effectively
  - Customers
  - Users
  - Team members
- Understand
  - Impacts to changes in requirements
  - Decisions, issues, and rationale

To Move from Data to Information…

- **Plan the Program's Process Needs**
- **Determine Basic Data Requirements**
- **Identify Information Products to meet Programmatic Goals**
  - **Define Characteristics of Information Products**
  - **Define Quality Requirements of Information Products**
- **Define "Information Manufacturing System"**
  - **Identify Tools Required to Store Data**
  - **Identify Software Needed to Produce Information Products**

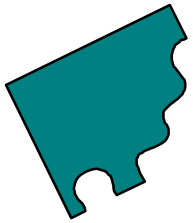
What is this Concept of Total Data Quality Management?

- **Quality data is fit for use ? concept of data quality is relative and depends on the receiver of the data and information**
- **Make data and information meet the “fit for use criteria” which implies more than “just being accurate”**

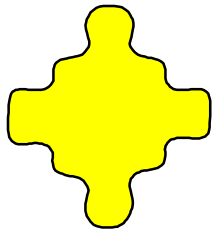
Taken from: Communications of the ACM; Feb 1998, Vol. 41, No. 2 , pp 58–65

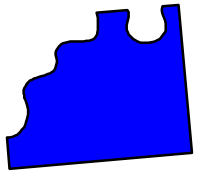
Define Quality Requirements of Information Products

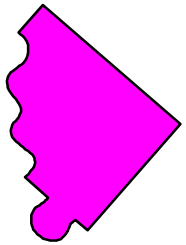
- **Contextual**
  - Relevancy
  - Value-Added
  - Timeliness
  - Completeness
  - Amount of data
- **Representational**
  - Interpretability
  - Ease of Understanding
  - Concise
  - Consistent

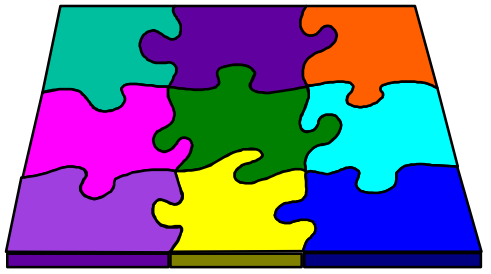


- **Intrinsic**
  - Accuracy
  - Objectivity
  - Believability
  - Reputation
- **Accessibility**
  - Access
  - Security









See Wang, Comm of the ACM, Feb 98/ Vol. 41, No. 2; pp 58-65

As You Plan, Consider…

Information Databases

Importance of data re-use

The entire life cycle…

What you need to plan

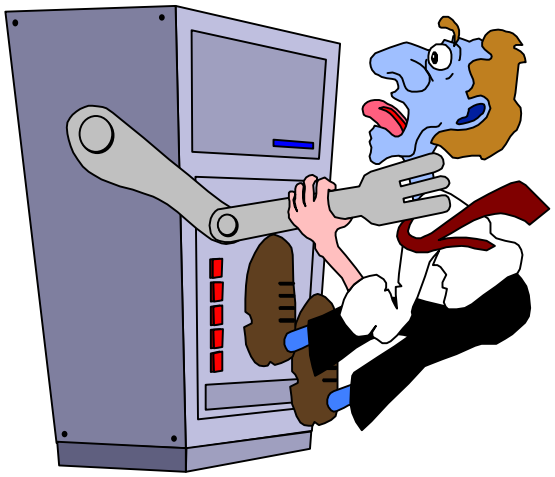
Tools required

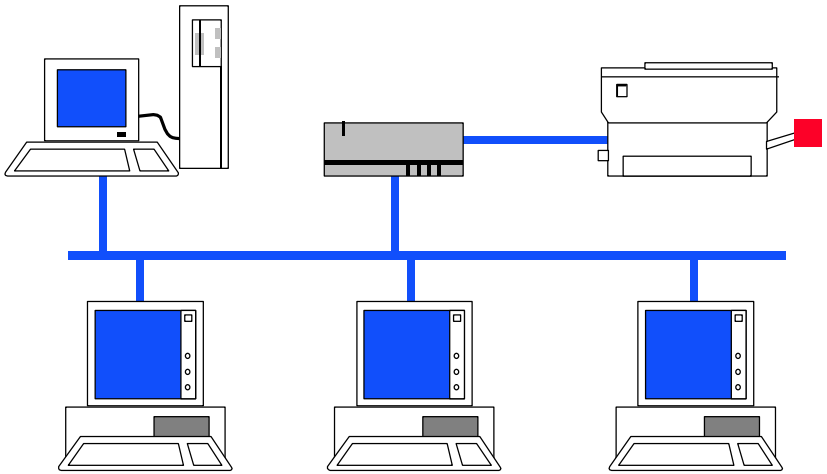
Information Databases

- **A repository that provides a capacity to maintain work products and outcomes from implementation of the processes for engineering a system in a controlled manner.**
  - **Provides the basis for controlled maintenance of the information needed by the multidisciplinary teams and management to efficiently and effectively accomplish their assigned tasks.**
- **Contains the requirements, configurations of a system (past, current, and planned), and all analyses and test results.**
  - **Allows for traceability**
  - **Supports the validation and verification tasks**
  - **Is essential for change management**
  - **Provides information to support decision making**

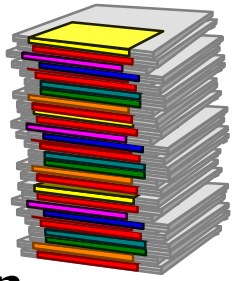
- **Term "Information Database" used 40 times**
- **Found in 16 of 33 Requirements**
- **Applies throughout Life Cycle**

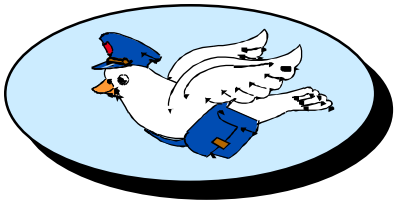
Information Database and EIA 632 Tasks (1 of 5)



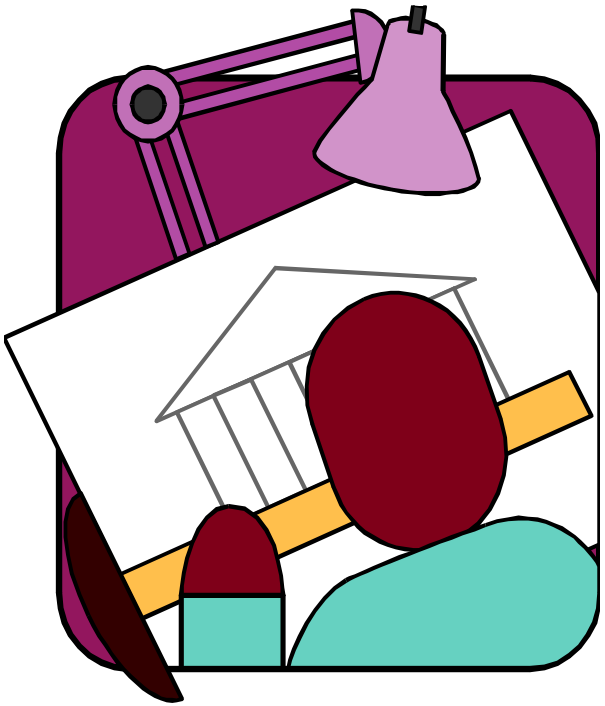


- **Establish Database**
  - **Requirement 5: task b**
- **Capture Appropriate Data**
  - **Requirement 12: task a**
- **Manage Database**
  - **Requirement 12: task g**
- **Disseminate Information**
  - **Requirement 13: (implied in all tasks)**



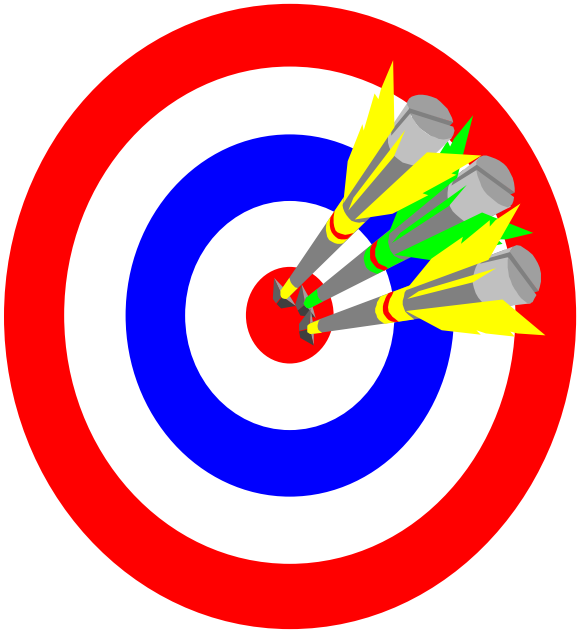


Information Database and EIA 632 Tasks (2 of 5)



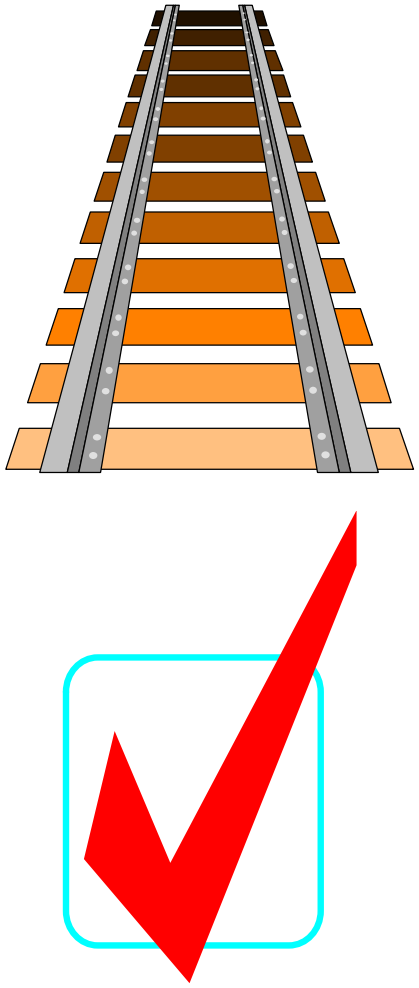
- **Validated System Technical Requirements**
  - **Requirement 16: task i**
- **Logical Solution Representations & Set of Validated Derived Requirements**
  - **Requirement 17: task f**
- **Design Solution Work Products (include key decisions, rationale, results of tradeoff analyses, assumptions)**
  - **Requirement 19: task d**

Information Database and EIA 632 Tasks (3 of 5)



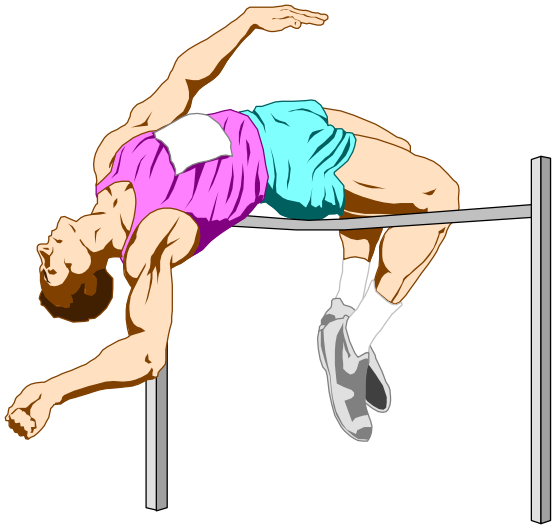
- **Effectiveness Analyses**
  - **Requirement 22: task f**
- **Outcomes of Tradeoff Analyses**
  - **Requirement 23: task c**
- **Outcomes of Risk Analyses**
  - **Requirement 24: task f**

Information Database and EIA 632 Tasks (4 of 5)



- **Validation Results**
  - **Acquirer Requirements**
    - **Requirement 26: task e**
  - **Other Stakeholder Requirements**
    - **Requirement 27: task e**
  - **System Technical Requirements**
    - **Requirement 28: task h**
  - **Logical Solution Representations**
    - **Requirement 29: task g**
  - **End Product**
    - **Requirement 33: task e**

Information Database and EIA 632 Tasks (5 of 5)



- **Verification Results**
  - **Design Solution**
    - **Requirement 30: task d**
  - **Delivered End Product**
    - **Requirement 31: task d**
  - **Readiness Demonstration for Enabling Products and Processes**
    - **Requirement 32: task d**

Why Is Data Re-use So Important?

- **Minimize**
  - **Maintenance costs**
- **Maximize**
  - **Data integrity**
  - **Data accuracy**
- **Help**
  - **Ensure timeliness of information delivery**
  - **Identify potential opportunity to reduce costs by reusing code or inventoried products**

What To Do…

- **Identify:**
  - **Information Products**
  - **Tools and Environment**
  - **Maintenance Resources**
- **Define:**
  - **Characteristics of Information Products**
  - **Quality Requirements of Information Products**
  - **"Manufacturing System" for production and maintenance of Information Products**
- **Consider:**
  - **Where data will be stored (what tool)**
  - **What stored data mean in your process (semantic meaning)**
  - **How will data be stored in the tool (schema)**
  - **Reduce storage of redundant data**
  - **Define data consolidation and change control process and procedures**

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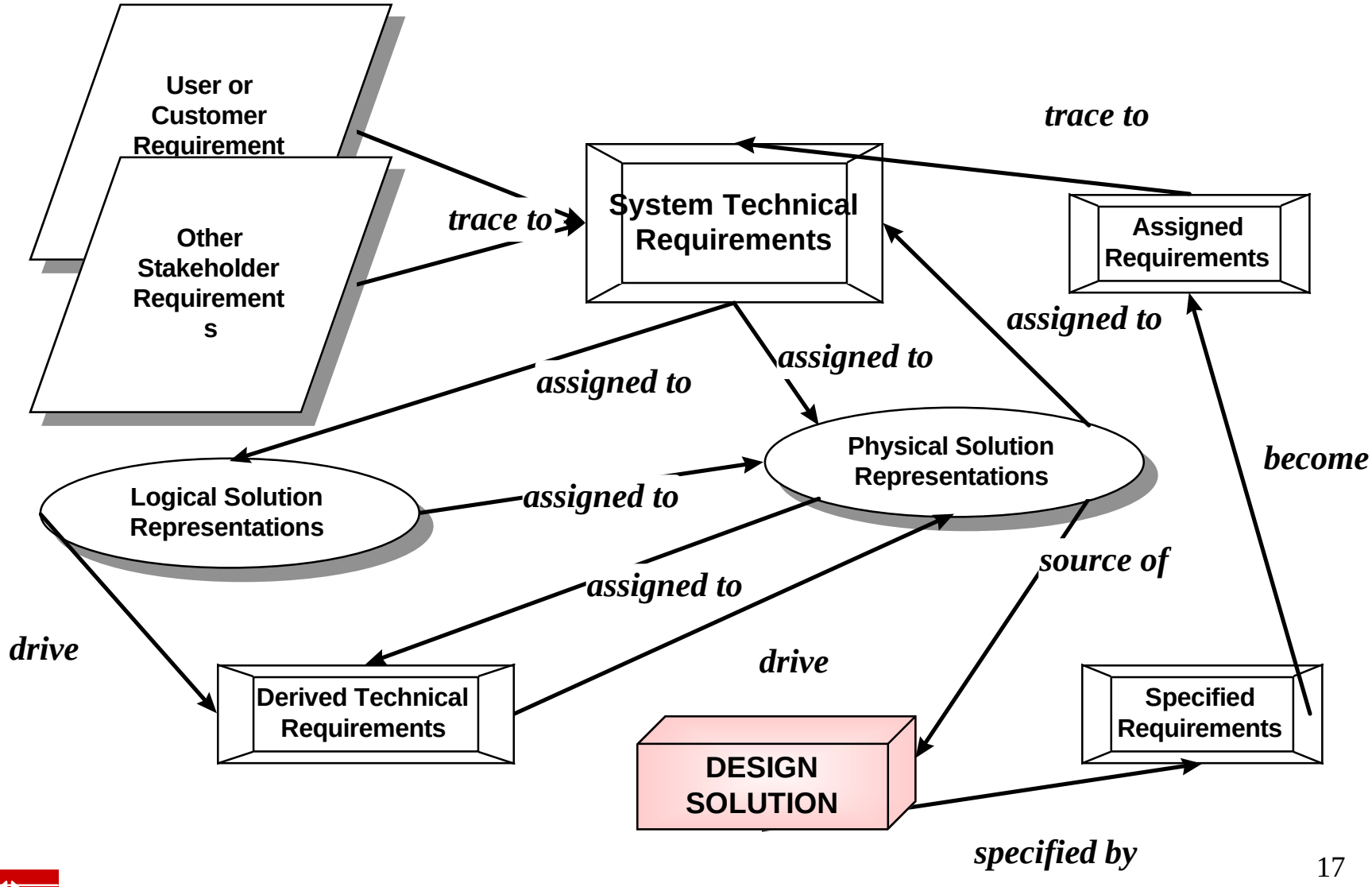
EIA 632 Requirements Management Semantics



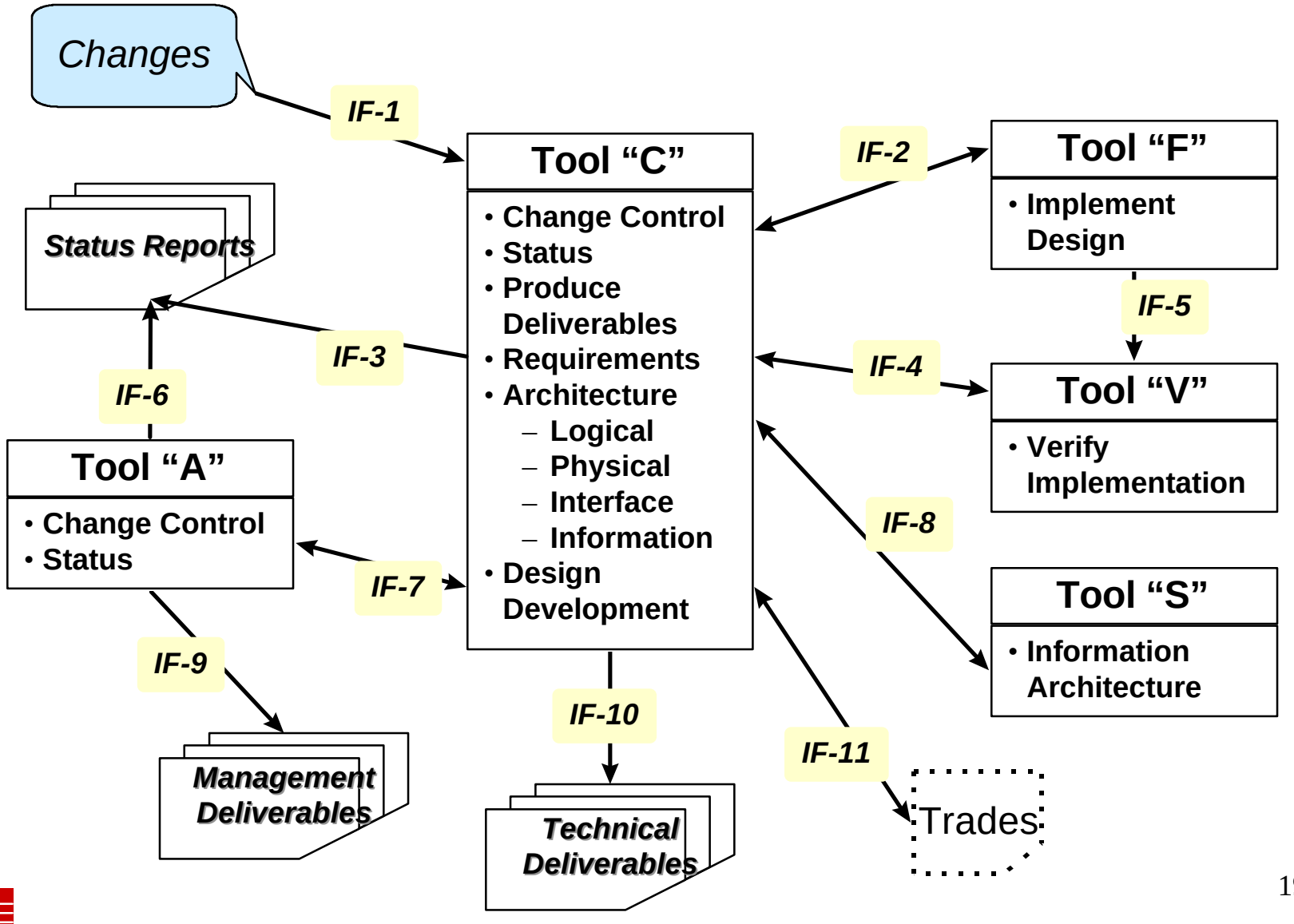
Process and Tool Enablers

Process Needs		Tool Selection Options					
		1	2	3	4	5	6
Control and Manage Changes		a	b, c	a, c	a, c	a, c	b
Report Status		z	b, c	z	a, c	a, c	a, z
Produce Deliverables		c	c, d	c	c	a, c	w
Develop Requirements		a, c	z	d, c	d, s, c	c	c
Develop Architecture	Logical	c	s	s, t, c	t, c	c	a
	Physical	c	f	z	c	c	c
	Interface	z	c	c	c	c	z
	Information	c	h	c	c, s	c, s	c
Develop Design		e, f	z	c	s, h, c	c	c
Implement Design		f	f	k	k, f	f	k
Verify Implementation		f, g	v	v	v, c	v	c
TOOLS REQUIRED		a, c, e, f, g, z	b, c, d, f, h, s, v, z	a, c, d, k, s, t, v, z	a, c, d, f, h, k, s, t, v	a, c, f, s, v	a, b, c, k, w, z

Option 5 Chosen

- **Min. # of tools**
- **Reduced # of tools for each process step (need)**
- **All tools in this option have Public APIs; interfacing is easier**
- **Tool "c" appears to be capable of covering many of the process steps (needs); assume Tool "c" has internal integration to move from one process step to another.**
- **Tool "c" has CAIV solution**
- **Tool vendors "c" and "a" have consultants to help define software interfaces**
- **Tool "c" vendor has resources to help develop interfacing software**

Tool Interfaces



Tool Costs (Initial + Maintenance) in $000s

Tool	Num. Seats	List		Maintenance			Projected Cost (w/o Discount)
		Seat	Total	15% /yr	Dev (Yr 2 -6)	Ops (Yr 7-30)	
A	5	70	350	52.5	262.5	252	864.5
C-1 (re)	200	3	600	90	450	2160	3210
C-2 (rm)	40	8	320	48	240	1152	1712
C-3 (api)	45	2	90	13.5	67.5	324	481.5
C-4 (exc)	10	15	150	22.5	112.5	540	802.5
C-5 (sa)	10	19	190	28.5	142.5	681.6	1014.1
C-6 (sd)	5	50	250	37.5	187.5	900	1337.5
F	10	50	500	75	375	1800	2675
V	5	200	1000	150	750	3600	5350
S	3	50	150	22.5	112.5	108	370.5
			3600	540	2700	11517.6	17817.6

Assumes:

- **30 year Program Life; 6 year Development; 300 Engineers during Development; all Engineers and Managers need easy access to the Information Database**
- **Maintenance starts Year 2**
- **No. of seats for maintenance reduced to 1/5th after Development**

Tool Interfaces Costs (in Months)

Inter-face	Type	Tools	Develop Cost (Mo.)	Maintain Cost (Mo.)	Projected Cost (Mo.)	Projected Cost ($000s)
IF-1	Uni (Ext)	→ C	3 x .25	360 x .01	4.35	87
IF-2	Bi (Int)	C ←→ F	3 x 1.5	360 x .1	40.5	810
IF-3	Uni (Int)	C → Rpt	3 x .25	360 x .01	4.35	87
IF-4	Bi (Int)	C ←→ V	3 x 2	360 x .1	42	840
IF-5	Uni (Int)	F ←→ V	3 x 1	360 x .01	6.6	132
IF-6	Uni (Int)	C → Rpt	3 x .25	360 x .01	4.35	87
IF-7	Bi (Int)	C ←→ A	3 x 2.5	360 x .5	181.5	3630
IF-8	Bi (Int)	C ←→ S	3 x 1.5	360 x .01	8.1	162
IF-9	Uni (Int)	C → Rpt	3 x 2	360 x .5	186	3720
IF-10	Uni (Int)	C → Rpt	3 x 1	360 x .5	181	3620
IF-11	Bi (Int)	C → Trades	3 x .25	360 x .5	180.75	3615
			35.5	810	845.5	16910

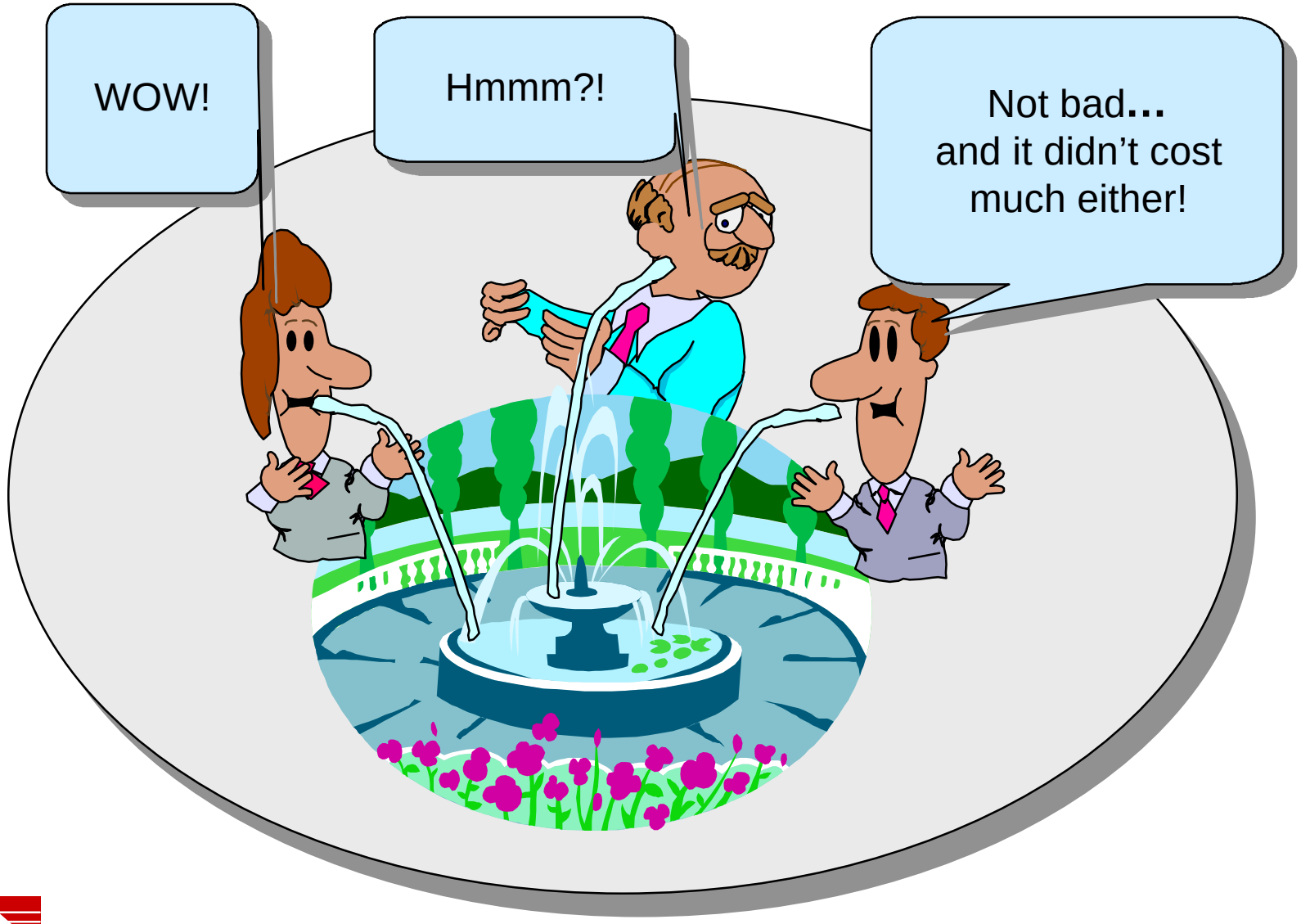
Assumes:
- **30 year Program Life; 6 year Development**
- **Optimistic Software Development Schedule**
- **Estimated 20 days/month; $1000/day consultant rate**
- **Minimal Schema changes (3 for each tool over Program Life)**

Tools + Tool Interfaces Costs (Hypothetical 30 Year Program)

- **Software, without Discount ($17,818K)**
  - **$3,600K Acquisition**
  - **$2,700K Development Maintenance**
  - **$11,518K Operational Maintenance**
- **Tools Interfaces ($16,910K)**
  - **$710K Development**
  - **$16,200K Maintenance (Development + Operations)**

- **Software, with 40% Discount ($ 10,691K)**
  - **$2,160K Acquisition**
  - **$1,620K Development Maintenance**
  - **$6,911K Operational Maintenance**
- **Tools Interfaces ($16,910K)**
  - **$710K Development**
  - **$16,200K Maintenance (Development + Operations)**

Data and Information Re-Use



Summary: Data Quality and Information Integrity

- **Need resources and planning to Establish and Maintain an Information Database**
- **Plan Information Product Needs for the Life Cycle**
  - **Data and Information are not the same**
- **Greater the number of tools needed to store the data, greater the chances of redundant data**
  - **Redundant data is a problem in data accuracy and data integrity**
- **Reduce number of tools needed to contain the data to support engineering process**

Summary: Tools Purchase and Maintenance

- **Initial tools purchase price is not the only life cycle cost**
- **Maintenance costs for tools mount up**
  - **Need to maintain bridges or other interfaces between the tools**
    - **Costs time and money**
    - **Increases possibility of data redundancy**
  - **Maintenance of tools interfaces is significant; special skills needed**
    - **Development: software**
    - **Administration: hardware and database**
  - **The more tools you have the more maintenance cost you have**
    - **~10 - 18% of purchase price of tool, annually**

Summary: Initial Skill Sets Needed

Need someone who:

- **Knows your engineering process**
- **Can facilitate a team in actualizing your process with the tools**
  - **Help in teambuilding**
- **Knows how to define and develop the software needed to exact and formulate information from data contained in the repository**
  - **Provide semantic mapping help**
  - **Develop automated user tools**
  - **Help define and detail a "users guide" for the tool set**
- **Knows the hardware side of setting up and maintaining data repositories**